PENNSTATE

1855

Constellation-X/ XEUS Science Objectives

The Interstellar/Intergalactic Medium

John Nousek (Penn State University)

Top ISM/IGM Objectives

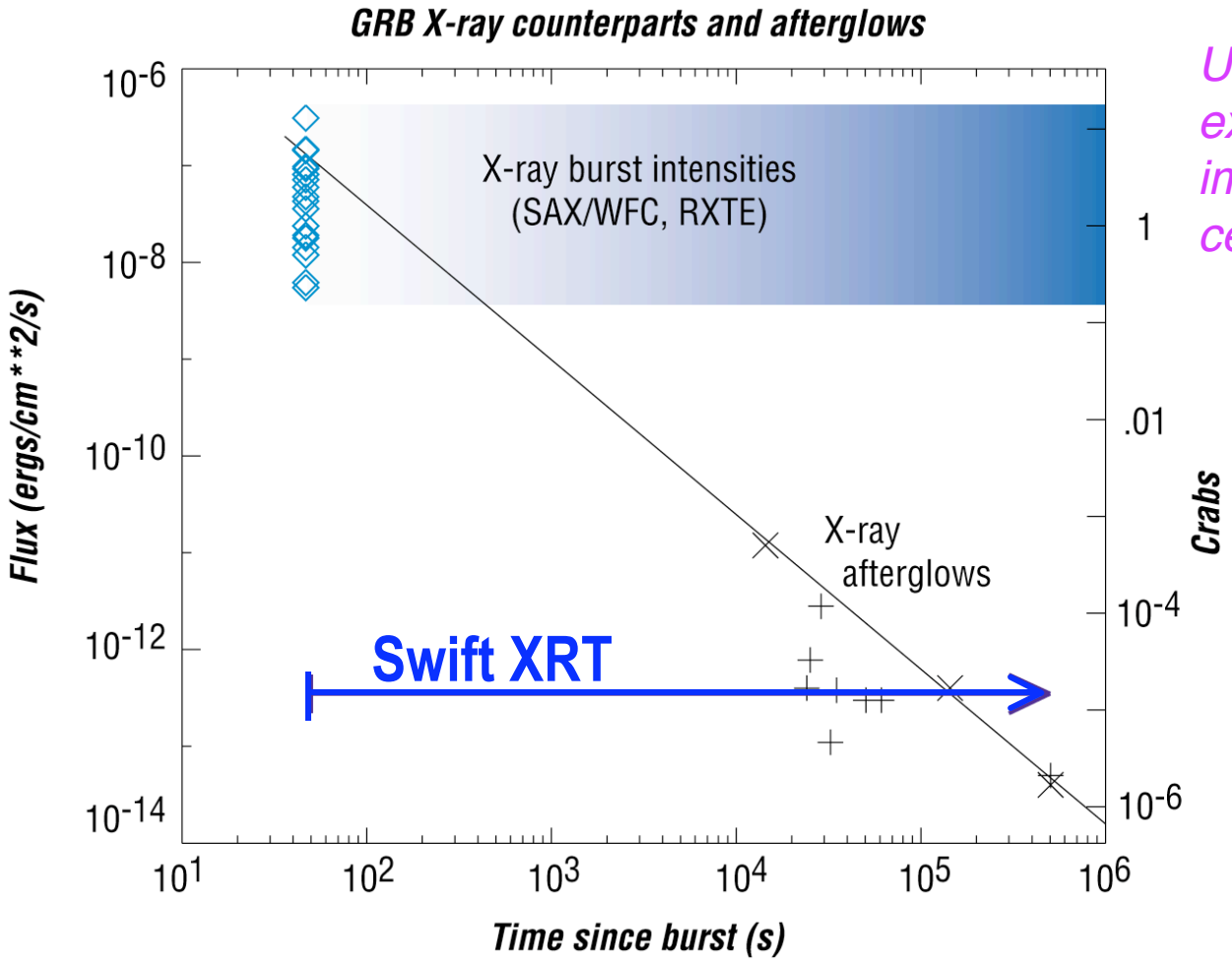
- X-ray spectroscopy of GRB at z>6
  - 'Core Sample of the Re-Ionizing Universe'
  - Driver for multiple Con-X requirements
- X-ray spectroscopy of lensed AGN at z>6
  - Steady State target with substantial intervening absorber
- Phase resolved spectroscopy of eclipsing Galactic binary source
  - Measurement of dust grain composition, including chemical states through EXAFS
- O VII/ O VIII absorption studies against bright background sources
  - Measures hot phase of ISM

Core Sample of Re-Ionizing Universe

- X-ray afterglow of z=4.5 GRB already seen
- HETE-2 standard candle analysis infers z=14 GRB
- Theoretical predictions (Reichard & Lamb, Meszaros, Guo, etc.) suggest GRBs can be visible to z= 15-30

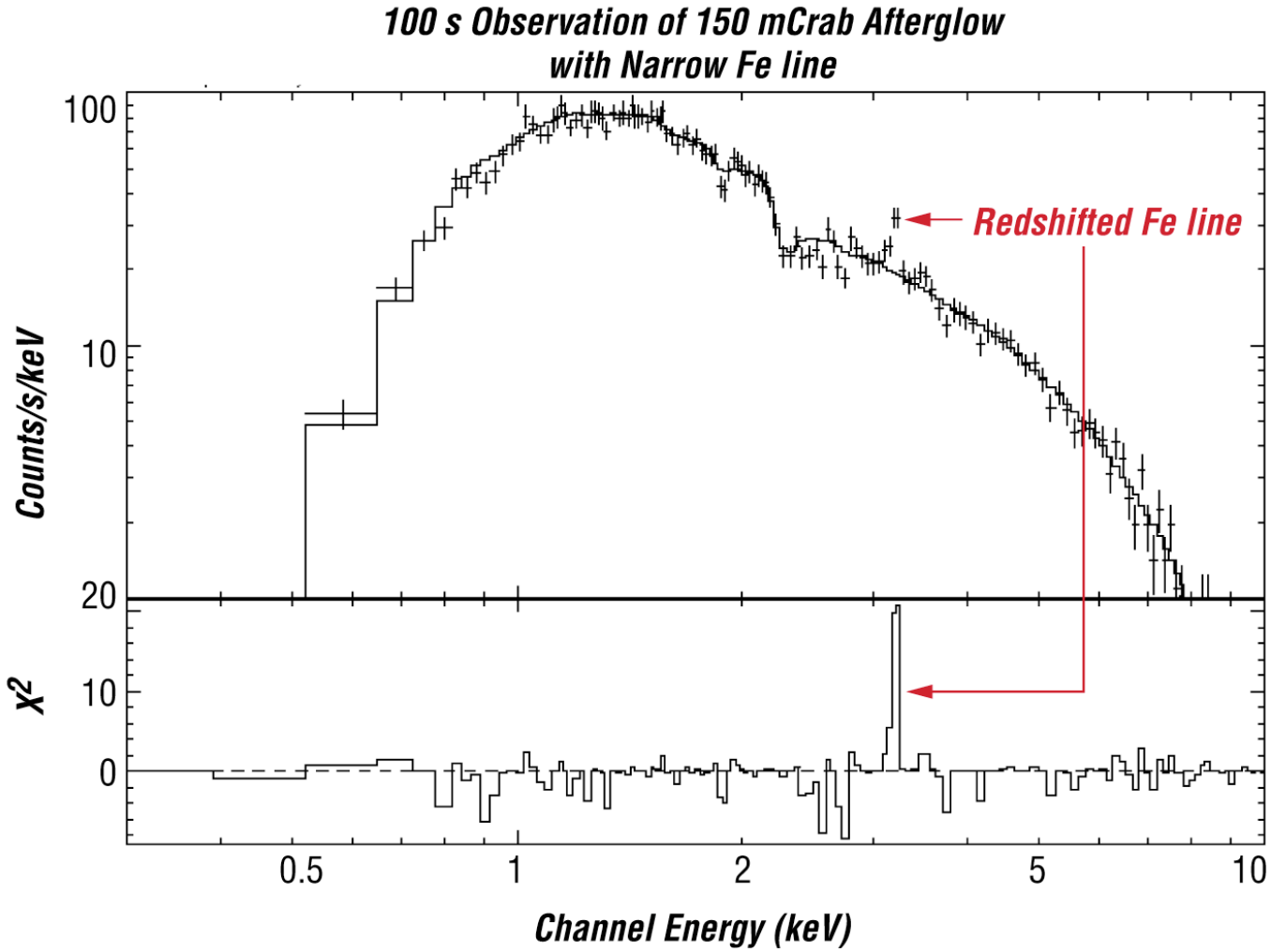
- SDSS studies find Gunn-Peterson absorption in QSOs at z>6 (Fan et al. 2002)
  - Fe edge redshifted to ~1 keV
  - Si, S edges redshifted to ~0.3 keV

Brilliant Flash



Use Imaging Mode: 0.1 s exposure time integrated image provides accurate centroids for F_x<26 Crabs

Redshift Measurement

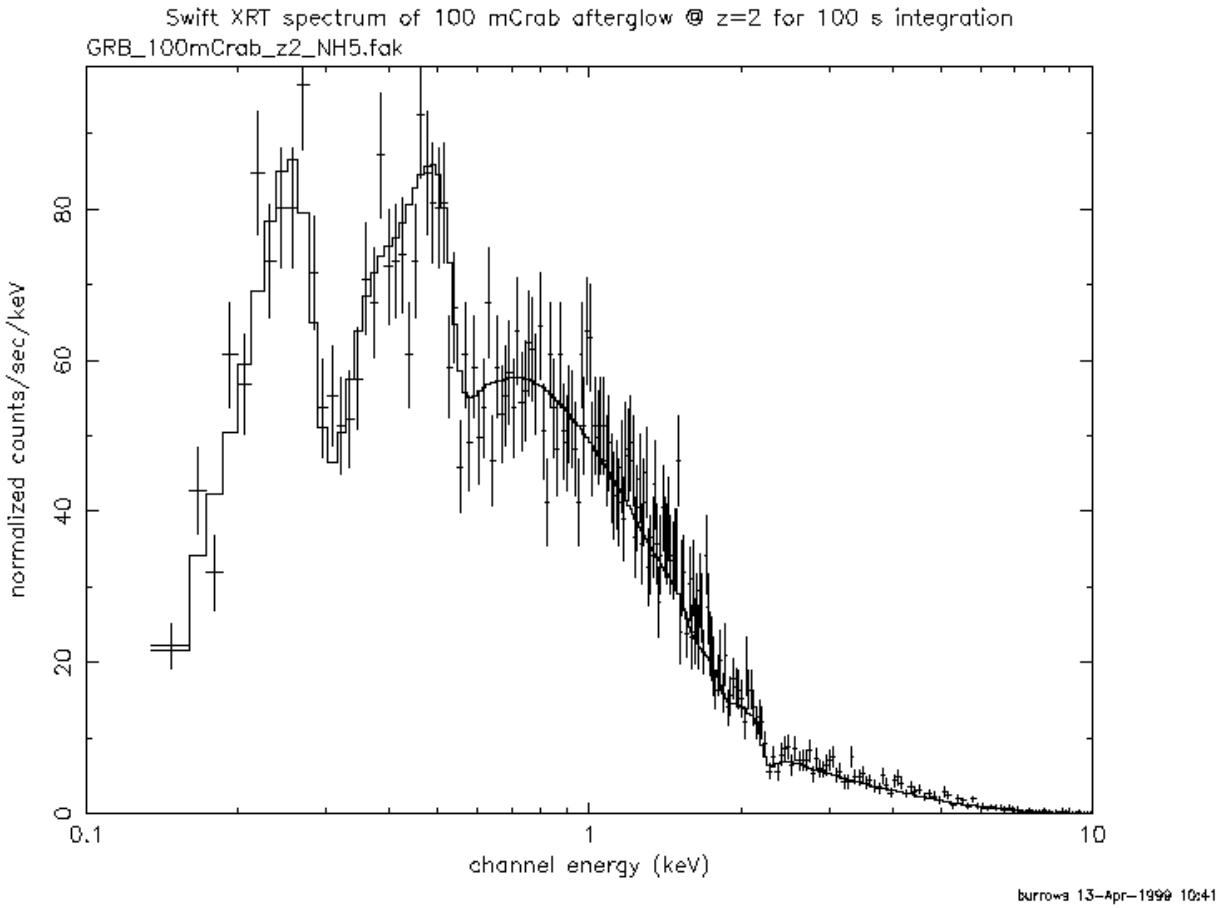


Spectral Parameters:

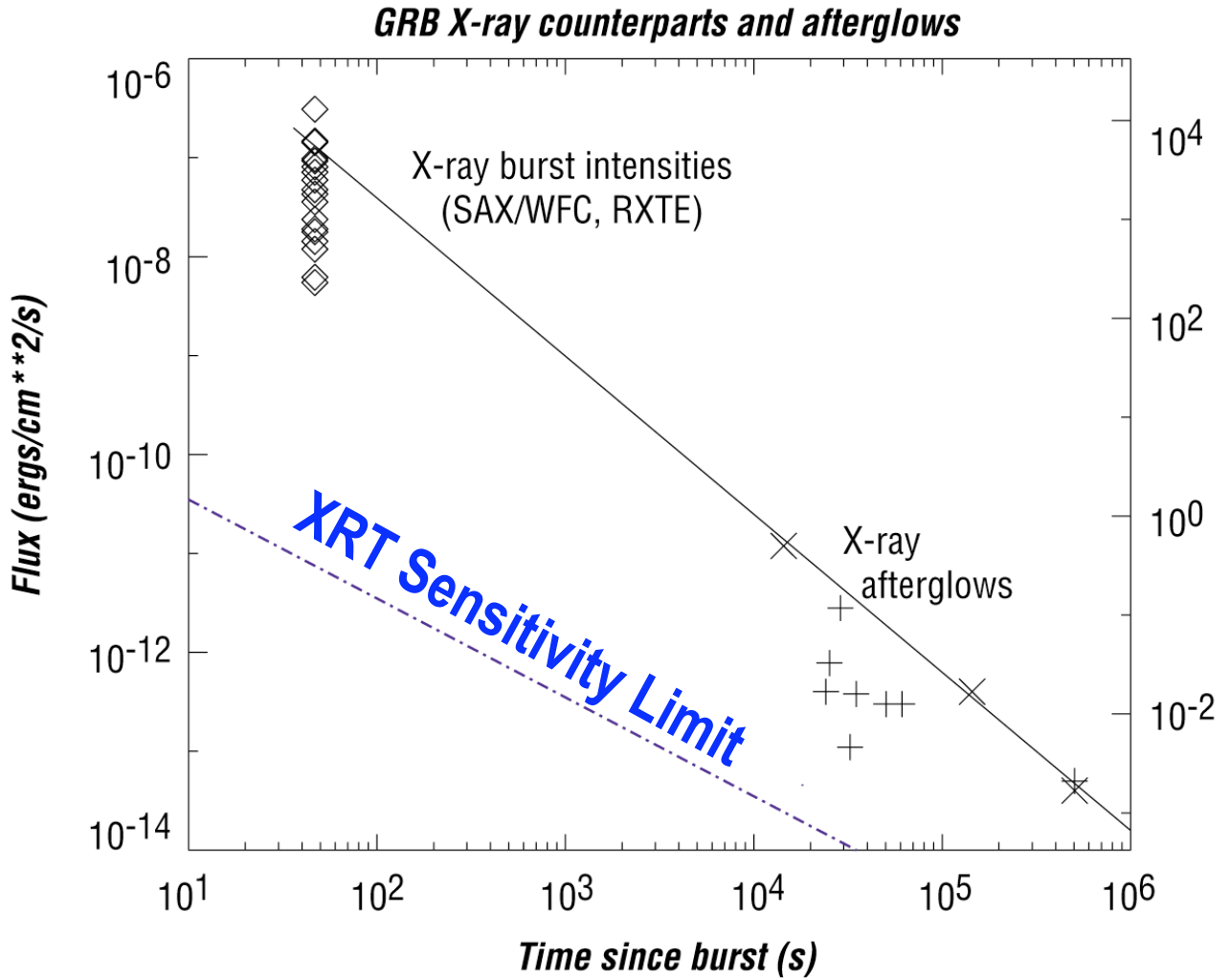
- $I(E) = A\ E^{-2.0}$
- $N_H = 2.5 \times 10^{22}$
- Eline = 6.4 keV
- R = 150 cps
  (150 milliCrab source)
- t = 100 s

Simulated XRT spectrum

Simulated spectrum of a 100 mCrab afterflow observed for 100 seconds with the Swift XRT. The spectrum assumed here is a power law with photon index 2.0, absorbed by 5×10^{20} cm^{-2} at the source, which is at z=2.0. The redshift measured by a fit to this simulated spectrum is 2.0 +/- 0.3.



XRT Sensitivity

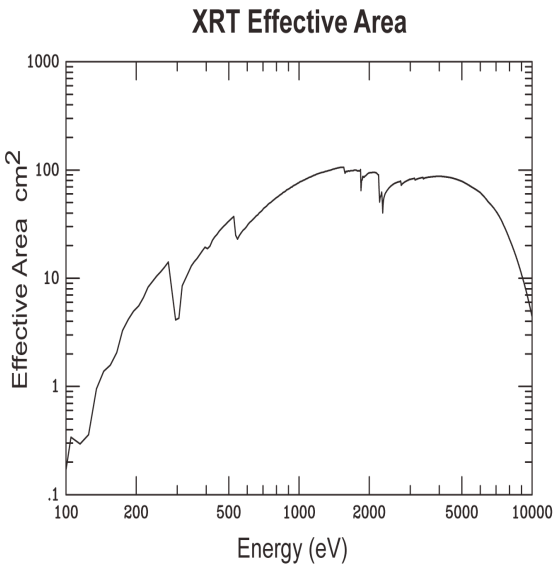


Use Timing Mode and/or Photon-Counting Mode:

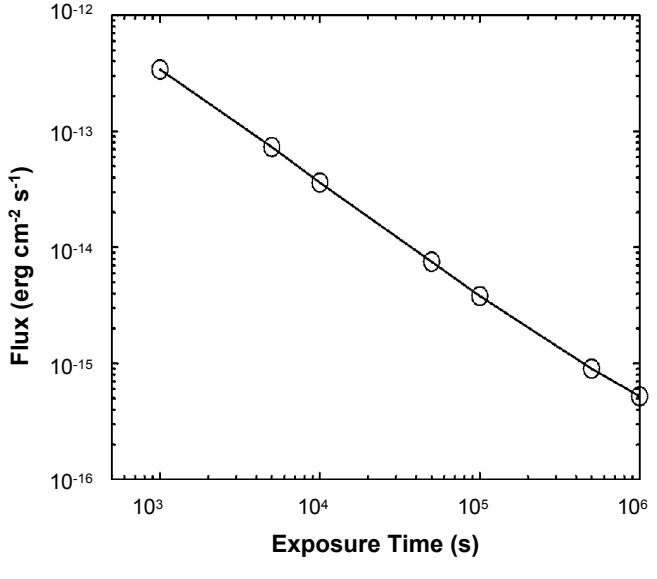
Timing Mode: Accurate Light Curves and Spectroscopy for 20 mCrabs < I < 8.5 Crabs

Photon-Counting Mode: Accurate Position, Lightcurve, and Spectroscopy for I <20 mCrabs

Swift XRT Sensitivity



Effective area of XRT, including mirrors, filters and detector QE



Faintest source (0.2-10 keV band; 5 sigma) which can be detected by XRT

- 1 cps per mCrab for a typical source spectrum.
- High resolution spectra for at least ~10 hours after the burst
- Spectrophotometry for up to 4 days
- Broad-band lightcurves can be followed for weeks

Time is of the Essence

- If Con-X has ~10,000 cm^2
  - At T+200 s: GRB ~ 1 Crab _ 10^7 cts in 100 s
  - At T+2000 s: GRB ~ 10 mCrab _ 10^6 cts in 1000 s
  - At T+20,000 s: GRB ~ 0.3 mCrab _ 3 x10^5 cts in 10,000 s
  - At T+10^5 s: GRB ~ 0.02 mCrab _ 2 x10^5 cts in 10^5 s
- For R ~ 1000 spectroscopy
  - 10^6 cts means 3% = 1_ for narrow absorption line
    - Edge using 10-100 bins reduces to 1-0.3% (1_)
- If Con-X has 100,000 cm^2, things are much better

Requirements on Con-X

- Rapid response (and a GRB detector)
- Large collecting area
- Good spectral resolution (but not extreme)
- High detector counting rates
- Response below 2 keV